

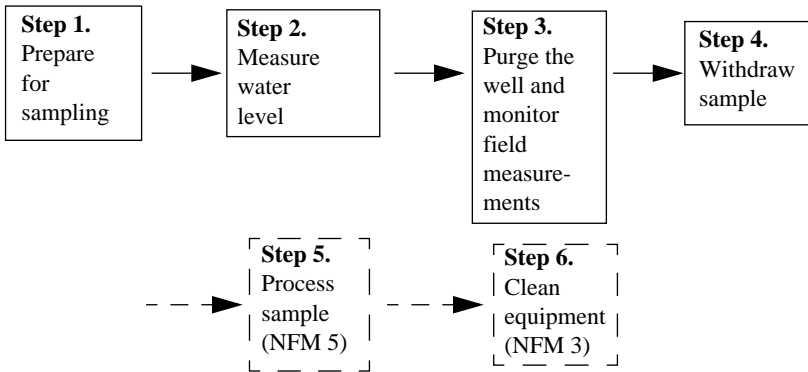
4.2.2 MONITORING WELLS

Ground-water samples commonly are collected from monitoring wells using portable sampling equipment. Sampling equipment can be dedicated for use at a specific well or can be installed permanently for the duration of the study, if using the same equipment for several wells poses a substantial risk of cross contamination.

Check NFM 2 for applications and limitations of various purging and sampling devices (pumps, bailers, and other samplers). Submersible pumps are recommended in general, but site characteristics can place limitations on the practical use of various types of sampling equipment. **If possible, the pump that is used for sampling also should be used for purging.**

- ▶ Select equipment that will not alter the chemical composition of the sample with respect to target analytes. Use only clean equipment.
- ▶ Several months in advance of sampling, quality assure the sampling equipment selected with an equipment blank(s) to verify that the equipment is suitable for the purpose of the study.
- ▶ Obtain permission for access to and collection of samples and data from the well.
- ▶ Document all field observations and any deviations from standard sampling procedures.

Protocols and guidelines for sampling from monitoring wells



Be sure that the field effort is adequately staffed and equipped. Check QC requirements before departing—QC samples require additional equipment and supplies. Implement good field practices and *CH/DH* techniques as applicable (duties typically performed by Clean Hands (*CH*) and Dirty Hands (*DH*) are indicated in the steps that follow).

Step 1. Prepare for sampling at a monitoring-well site (*DH/CH*).

- a. Set out safety equipment such as traffic cones and signs. Park vehicle in a position to prevent sample contamination from vehicle and traffic emissions and prevailing wind.
 - Check well-identification number and compare it with the well file and field notes.
 - Assign *CH/DH* tasks to field personnel.
- b. Describe well and site conditions in field notes and (or) on field forms, as appropriate (*DH*).
- c. Check site for hazardous conditions (NFM 9) (*DH*).
 - Test for toxic fumes if the well is in an enclosed structure or if there is reason to suspect the presence of organic vapors.
 - Examine the area for evidence of animal infestation and other potential safety hazards.

- d. Set up equipment and instruments for field measurements and sample withdrawal (*DH*).
 - Keep sample tubing shaded from direct sunlight to minimize changes in the temperature of the sample.
 - Calibrate field-measurement instruments (NFM 6).
- e. Spread clean plastic sheeting (for example, a polypropylene tarp) on the ground around the well to keep sampling equipment and sample tubing clean (*DH*). Prepare area to be used for field cleaning of equipment. Put on gloves.
- f. Set up sample processing and preservation chambers (usually in the water-quality field vehicle). Change gloves. Place filter unit and other necessary supplies for sample collection and processing into the processing chamber (*CH*).
- g. Remove cap from well casing and connect manifold to pump (if using a pump) (*DH*). Verify clear access downhole by lowering a section of blank pipe through the depth interval to be sampled and raising it slowly. Do not drop the pipe or otherwise stir up particulates in the process of lowering and raising the pipe.
 - i. Connect the antibacksiphon valve in-line between the pump and manifold. (The antibacksiphon valve is a standard component of some submersible pumps.)
 - ii. Connect sample tubing to manifold, keeping tubing as short as possible.
 - iii. From manifold, connect lines to flowthrough chamber, processing chamber, and waste discharge. Keep the discharge end of sample tubing (handled by *CH*) sealed until used. Keep tubing for sample and field-measurement lines as short as possible and protected from direct sunlight and extreme temperatures.
 - Tubing that transfers sample to the processing chamber must be of noncontaminating material (*CH*).
 - Tubing connected to a flowthrough chamber for field measurements that is used for that purpose only (not for sampling) can be of any material, but should be transparent in order to see if bubbles or sediment are entrained in the flow (*DH*).
 - Tubing connected to the manifold that is used solely to discharge purge water or other wastewater can be of any material, but it needs to be long enough to direct water away from the work area (*DH*).

Step 2. Measure water level (*DH*).

Procedures and equipment for water-level measurement depend on well type and construction and the presence of nonaqueous liquid phases.

- a. Put on gloves before chalking a steel tape. Using a weighted steel or electric tape in a nonpumping well, record two or more consecutive water-level measurements to the nearest 0.01 ft (for wells of less than 200 ft to water); repeat measurement until precision is within 0.02 ft (U.S. Geological Survey, 1980). At deep wells, calculate the compensation factor to account for tape stretching.
- b. Record water-level measurements on field forms (fig. 4-7).
- c. Set up a system to measure water levels throughout purging. Electrical tapes or submersible pressure transducers are recommended—repeated measurements with a steel tape can be cumbersome and can generate turbidity in the water column.

RULE OF THUMB: The initial water-column height should be greater than 4 ft plus the length of the sampling device.

Step 3. Purge the well and monitor field measurements (*DH*).

Purge wells with a pump, if possible. Operate pumps in a manner that minimizes turbidity. **Do not use a bailer for purging** unless well characteristics or other constraints exclude other alternatives and the turbidity during and after bailing is less than about 5 NTU or at background level. Measuring water levels is recommended throughout purging to document drawdown and the location of the water level with respect to the screened/open interval and the pump intake.

- ▶ Use the same pump equipment for purging that will be used to collect samples, if possible.
- ▶ **Avoid refueling or changing equipment, and do not stop the pump during the final phase of purging and sample collection.** Be aware of study objectives and potential sources of contamination. For example, avoid fueling the equipment on the same day that samples are collected for VOC analysis.

- ▶ Adjust the flow rate at the pump (preferable) or use a manifold with a flow-regulating valve (needle valve). The flow-regulating valve is necessary to prevent backpressure and air bubbles from building in the tubing.
- Pump at a rate that does not significantly lower the water level. The water level should be maintained above the screened or open interval.
- Flow should not be halted or the flow rate changed suddenly during the final phases of purging and sampling.

TECHNICAL NOTES:

- A dual-pump system often is used when the water table is deeper than 250 ft and (or) a large volume of water must be purged. Position, in series, a submersible turbine or gear pump downhole and a centrifugal pump at the surface.
 - Water discharging from the slow-pumping submersible pump is used for field measurements and sample collection, while the centrifugal pump removes the required volume of purge water at a faster rate. Changes in pumping rate might increase turbidity.
 - Dissolved oxygen, Eh, or turbidity should not be measured while using a dual pumping system. Record measurements while operating only the submersible pump.
- When the water table is less than 25 to 30 ft from land surface, a peristaltic pump sometimes is used for small-diameter wells. A peristaltic pump or other comparable suction device can affect dissolved-oxygen concentrations and Eh measurements unless low-gaseous-diffusion tubing such as Tygon™ is used (NFM 2).
- An inflatable packer sometimes is set above and below the screened/open interval, with a pump intake located within the screened/open interval.
 - Packers, which can fail to form a complete seal between aquifer intervals, should be used with pressure transducers to indicate whether water is leaking past the packers or short circuiting in the aquifer.
 - The materials of which the packer is made also might affect sample chemistry by leaching or sorbing target analytes.

- a. Calculate and record well volume (figs. 4-6 and 4-7) using the static depth to water measured in Step 2, as follows:

$V = 0.0408HD^2$ [Volume, in gallons = (0.0408) x (Height of water column, measured in feet as well depth minus water level) x (inside Diameter² of the well, in inches)]. Note that depth to bottom of well and inside casing diameter must be known to calculate well volume.

- b. Lower a submersible pump, followed by a water-level sensor, to the desired location of the pump intake. (The pump position is fixed if the monitoring well has a permanently installed sampling system.) Move the equipment slowly and smoothly through the water column to avoid stirring up particulates. The intake can be either lowered continually while purging to the final depth desired or placed immediately at its final position. Note that the final pump intake position always is at the point of sample collection.
- Position the pump intake at least 3 ft (≈0.9 m) below static water surface and a minimum distance above the top of the screened/open interval of 10 times the well diameter (for example, 20 in. for a 2-in. well diameter), if the sample is to represent the entire screened or open interval of aquifer. The location of the intake might be different if the study objective requires collecting the sample from a point within the screened/open interval or from wells in which packers are installed.
 - Place water-level sensor (electric tapes) a maximum of 1 ft (≈0.3 m) below the water surface.
- c. Position the pump intake.
- If final intake position is above the screened or open interval, do not exceed 1 ft (≈0.3 m) of drawdown.
 - If final intake position is within the screened or open interval, do not exceed 0.5 ft (≈0.15 m) of drawdown. The final pumping rate should be as slow as necessary to avoid causing turbidity.

- d. Start the pump, channeling initial discharge to waste.
 - Gradually increase and (or) adjust the pumping rate to limit drawdown to between 0.5 and 1 ft (≈ 0.15 to ≈ 0.3 m). Control the flow rate through the field-measurement tubing from the pump, if possible; or use a flow-regulating valve on the manifold. Do not use a flow-splitting valve to adjust flow rate.
 - Record changes in water level during purging.
 - Do not halt or suddenly change the flow rate during the purging/sample collection process. The pump must produce a solid stream of water during field measurements or sample collection. Adjust the pumping rate to eliminate air or gas bubbles or pump cavitation.
- e. Do not move the pump during field measurements or sample collection after intake has been set at the final location. The final depth of pump intake must be the same for making field measurements as for sample collection.
- f. Discharge water to waste until sediment is cleared from the flow. Begin flow through the flowthrough chamber for field measurements. Regulate the flow to the flowthrough chamber, as required, for measurements of pH and dissolved oxygen (NFM 6).
- g. Record the start time of purging, the pumping rate(s), water levels, and final location of pump intake (fig. 4-7). If water is flowing through more than one conduit (such as valve and manifold lines), calculate flow rate by summing the flow rate through each conduit.

- h. Purge a minimum of three well volumes or the purge volume dictated by study objectives. (Check exceptions to the three-well-volume procedure described on p. 69.)
- Record water-level and field measurements and time of measurement throughout purging (fig. 4-7; NFM 6).
 - The final pumping rate toward the end of purging (when stability of five or more sets of field measurements are being monitored) must be the same as the pumping rate during sample collection.
 - Check for special instructions regarding any field-measurement or field-analysis requirements based on study objectives.
 - Contain and dispose of purge water as required by Federal, State, or local regulations. Do not discharge purge water from one well into another without proper authorization. Discharge the water far enough away from a well or well cluster so as not to affect water quality.
- i. Check field-measurement data against stability criteria (fig. 4-7), as instructed in NFM 6. Record the time purging ended and note any deviations from standard well-purging procedures.

Step 4. Withdraw ground water (CH).

Put on gloves and begin sample collection immediately after field measurements have been completed.

Pumped samples—

- a. Check that sample tubing is properly secured within the processing chamber. Direct the sample flow through sample tubing to the processing chamber.
- b. Use the flow-regulating valve on the manifold to adjust sample flow to be smooth and uniform; avoid splashing while filling sample bottles.
- c. Go to Step 5.

RULE OF THUMB: The rate of flow for filling sample bottles should not exceed

- 500 mL/min for bottles 250 mL or greater in volume,
or
 - 150 mL/min for 40-mL VOC vials.
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Nonpumped samples—

- a. Field rinse the sampler and sampler emptying device (and compositing device, if used) three times before collecting the sample. Deploy the sampler so as to minimize disturbance to the water column and aquifer materials.
 - i. Use a reel to keep sampler line clean and untangled.
 - ii. Lower sampler smoothly, entering water with as little disturbance as possible.
 - iii. Allow sampler to fill, then withdraw sampler smoothly.
 - iv. Shake water in sampler vigorously to rinse all interior surfaces.
 - v. Attach sample-delivery tube or bottom-emptying device to sampler and drain the rinse water through the sampler.
 - vi. Repeat rinse procedure at least twice.

- b. Repeat (a) i –iii to withdraw ground water for the sample.

TECHNICAL NOTE: When a device is lowered and raised through the water column, the disturbance to the water column can result in outgassing or degassing of ambient dissolved gases and an increase in concentrations of suspended particulates. Repeated movement of the device through the water column exacerbates these effects and can result in substantial modification of the ambient water composition and chemistry.

- c. Composite the bailed sample or set up bailer in an enclosed or protected space.

Step 5. Process sample → Refer to NFM 5.

Step 6. Clean equipment → Refer to NFM 3.

At contaminated sites, use sample tubing that is disposable or dedicated to that site to avoid lengthy field-cleaning procedures and to minimize the risk of cross-contamination between wells.

- Rinse sampling equipment with deionized water before the equipment dries.
- Clean equipment to be used at another well during the same field trip after the DIW rinse and before moving to the next site.
- Collect field blanks used to assess equipment-cleaning procedures directly after the sampling equipment has been cleaned in the field or after moving to the next site and before sampling, as dictated by the data-quality requirements of the study (section 4.3).